07-03-00 A

Practitioner's Docket No. 944-003.18 ***PATENT***

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of
inventor(s): Esa MALKAMAKI, Deepak MATHEW, Kari PEHKONEN and JUSSI KAHTAVA

WARNING: *37 C.F.R. § 1.41(a)(1) points out:*

"(a) A patent is applied for in the name or names of the actual inventor or inventors.

"(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.63, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(i) is filed supplying or changing the name or names of the inventor or inventors."

For (title): METHOD OF SENDING FEEDBACK INFORMATION IN A FAST AUTOMATIC REPEAT REQUEST FORMING PART OF AN OVERALL WIRELESS COMMUNICATION SYSTEM

CERTIFICATION UNDER 37 C.F.R. 1.10*
(Express Mail label number is mandatory.)
(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date June 30, 2000 **in an envelope as "Express Mail Post Office to Addressee," mailing Label Number** EL628636875US **addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.**

Judith Schick
(type or print name of person mailing paper)

Judith Schick
Signature of person mailing paper

WARNING: *Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

"WARNING: *Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).*
*"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

1. Type of Application

This new application is for a(n)

(check one applicable item below)

☒ Original (nonprovisional)

☐ Design

☐ Plant

WARNING: Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

WARNING: Do not use this transmittal for the filing of a provisional application.

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

☐ Divisional.

☐ Continuation.

☐ Continuation-in-part (C-I-P).

2. Benefit of Prior U.S. Application(s) (35 U.S.C. 119(e), 120, or 121)

NOTE: A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. 112. Each prior application must also be:

(i) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or

(ii) Complete as set forth in § 1.51(b); or

(iii) Entitled to a filing date as set forth in § 1.53(b) or § 1.53(d) and include the basic filing fee set forth in § 1.16; or

(iv) Entitled to a filing date as set forth in § 1.53(b) and have paid therein the processing and retention fee set forth in § 1.21(l) within the time period set forth in § 1.53(f).

37 C.F.R. § 1.78(a)(1).

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

WARNING: If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

WARNING: When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application must be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

☐ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed

A. Required for filing date under 37 C.F.R. § 1.53(b) (Regular) or 37 C.F.R. § 1.153 (Design) Application

9 Pages of specification

4 Pages of claims

1 Sheets of drawing

WARNING: DO NOT submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 CFR 1.84, see Notice of March 9, 1988 (1990 O.G. 57-62).

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page . . ." 37 C.F.R. 1.84(c)).

(complete the following, if applicable)

☐ **The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. 1.84(b).**

☐ formal

☒ informal

B. Other Papers Enclosed

____ Pages of declaration and power of attorney

1 Pages of abstract

____ Other

4. Additional papers enclosed

☐ Amendment to claims

☐ Cancel in this applications claims _____ before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)

☐ Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)

☐ Preliminary Amendment

☐ Information Disclosure Statement (37 C.F.R. 1.98)

☐ Form PTO–1449 (PTO/SB/08A and 08B)

☐ Citations

- ☐ Declaration of Biological Deposit
- ☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.
- ☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative
- ☐ Special Comments
- ☐ Other

5. Declaration or oath (including power of attorney)

NOTE: A newly executed declaration is not required in a continuation or divisional application provided that the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under § 1.47, then a copy of that declaration must be filed accompanied by a copy of the decision granting § 1.47 status or, if a nonsigning person under § 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 C.F.R. §§ 1.63(d)(1)–(3).

NOTE: A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name including family name and at least one given name, without abbreviation together with any other given name or initial, and the residence, post office address and country or citizenship of each inventor, and state whether the inventor is a sole or joint inventor. 37 C.F.R. § 1.63(a)(1)–(4).

☐ Enclosed

Executed by

(check **all** *applicable boxes)*

- ☐ **inventor(s).**
- ☐ **legal representative of inventor(s).** 37 CFR 1.42 or 1.43.
- ☐ **joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.**
  - ☐ This is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached. *See* item 13 below for fee.

☒ Not Enclosed.

NOTE: Where the filing is a completion in the U.S. of an International Application or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

- ☐ Application is made by a person authorized under 37 C.F.R. 1.41(c) on behalf of *all* the above named inventor(s).

(The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently).

- ☐ Showing that the filing is authorized. *(not required unless called into question. 37 CFR 1.41(d))*

6. **Inventorship Statement**

WARNING: If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

☐ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

7. **Language**

NOTE: An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of $130.00 required by 37 CFR 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 CFR 1.52(c).

☒ English

☐ Non-English

☐ The attached translation includes a statement that the translation is accurate. 37 C.F.R. 1.52(d).

8. **Assignment**

☒ An assignment of the invention to Nokia Mobile Phones LTD

☐ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☒ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters-one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: A newly executed "CERTIFICATE UNDER 37 CFR 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

☐ is (are) attached.

☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 CFR 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 C.F.R. 1.16)

A. ☒ Regular application

CLAIMS AS FILED

Number filed	Number Extra	Rate	Basic Fee 37 C.F.R. 1.16(a) $690.00
Total 17 Claims (37 CFR 1.16(c)) − 20 =	0	× $18.00	0
Independent 3 Claims (37 CFR 1.16(b)) − 3 =	0	× $78.00	0
Multiple dependent claim(s), if any (37 CFR 1.16(d))		+ $260.00	

☐ Amendment cancelling extra claims is enclosed.

☐ Amendment deleting multiple-dependencies is enclosed.

☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).

Filing Fee Calculation $ 690.00

B. ☐ Design application
$310.00 —37 CFR 1.16(f))

Filing Fee Calculation $_____

C. ☐ Plant application
$480.00 —37 CFR 1.16(g))

Filing fee calculation $_____

11. Small Entity Statement(s)

☐ Statement(s) that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is (are) attached.

WARNING: "Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under § 1.53 as a continuation, division, or continuation-in-part (including a continued prosecution application under § 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this section." 37 C.F.R. § 1.28(a)(2).

(complete the following, if applicable)

☐ Status as a small entity was claimed in prior application

_____ / _____, filed on _____, from which benefit is being claimed for this application under:

35 U.S.C. ☐ 119(e),
☐ 120,
☐ 121,
☐ 365(c),

and which status as a small entity is still proper and desired.

☐ A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of **A, B** or **C** above)

$_____

NOTE: Any excess of the full fee paid will be refunded if small entitiy status is established and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 CFR 1.28(a).

12. Request for International-Type Search (37 C.F.R. 1.104(d))

(complete, if applicable)

☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☒ Not Enclosed

☒ No filing fee is to be paid at this time.
(This and the surcharge required by 37 C.F.R. 1.16(e) can be paid subsequently.)

☐ Enclosed

☐ Filing fee $ _____

☐ Recording assignment
($40.00; 37 C.F.R. 1.21(h))
(See attached "COVER SHEET FOR ASSIGNMENT ACCOMPANYING NEW APPLICATION".) $ _____

☐ Petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached
($130.00; 37 C.F.R. 1.47 and 1.17(i)) $ _____

☐ For processing an application with a specification in a non-English language
($130.00; 37 C.F.R. 1.52(d) and 1.17(k)) $ _____

☐ Processing and retention fee
($130.00; 37 C.F.R. 1.53(d) and 1.21(l)) $ _____

☐ Fee for international-type search report
($40.00; 37 C.F.R. 1.21(e)) $ _____

NOTE: 37 CFR 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 CFR 1.53(f) and this, as well as the changes to 37 CFR 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(l) must be paid, within 1 year from notification under § 53(f).

Total fees enclosed $_____

14. Method of Payment of Fees

☐ Check in the amount of $_____

☐ Charge Account No. _____ in the amount of $_____.

A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: *If no fees are to be paid on filing, the following items should not be completed.*

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.*

☐ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. _____:

☐ 37 C.F.R. 1.16(a), (f) or (g) (filing fees)

☐ 37 C.F.R. 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

☐ 37 C.F.R. 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☐ 37 C.F.R. §§ 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a)).

☐ 37 C.F.R. 1.17 (application processing fees)

NOTE: ". . .A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

☐ 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 CFR 1.311(b).

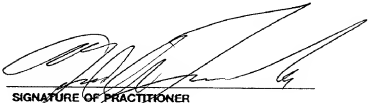
NOTE: 37 CFR 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . the issue fee. . . ." From the wording of 37 CFR 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

16. Instructions as to Overpayment

NOTE: ". . . Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

☐ Credit Account No. _____

☐ Refund



SIGNATURE OF PRACTITIONER

Reg. No. 27,550

Alfred A. Fressola

(type or print name of attorney)

Tel. No. (203) 261-1234

WARE, FRESSOLA, VAN DER SLUYS & ADOLPHSON LLP
755 Main Street, Building Five

P.O. Address
PO Box 224
Monroe, CT 06468

Customer No. 004955

☐ **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added _____

☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added _____

☐ Plus added pages deleting names of inventor(s) named in prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added _____

☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added _____

☒ **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)

☒ This transmittal ends with this page.

NC 18766
944-003.18

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION OF

Esa Malkamäki, Deepak Mathew, Kari Pehkonen

and

Jussi Kähtävä

FOR

METHOD OF SENDING FEEDBACK INFORMATION IN A FAST AUTOMATIC REPEAT REQUEST FORMING PART OF AN OVERALL WIRELESS COMMUNICATION SYSTEM

Express Mail No. EL628636875US

Technical Field:

The present invention relates to sending feedback data to a sender of packets in a wireless communication system and in particular is directed to a new feedback channel for use in fast hybrid automatic repeat request.

Background of the Invention:

Fast hybrid automatic repeat request (HARQ) has been proposed as a vehicle to solve receiver memory problems which occur when soft combining schemes are used in wireless communications. The fast HARQ requires that an acknowledgement (or the so-called forward order) be transmitted within the next radio frame after the transmission of packet(s) in the forward direction. Hybrid ARQ (HARQ) is a link adaption technique used to improve the performance of wireless communications. In a Type 1 Hybrid ARQ, there is soft combining which is a type of repetition coding in which the retransmitted packet is combined with the initially transmitted packet. In Type 2 Hybrid ARQ, an incremental redundancy scheme is used. In both Type 1 and Type 2 Hybrid ARQ, the soft decision values of the erroneous packet, if detected, must be stored in the receiver which in turn can lead to very high memory requirements at the receiver. Thus the amount of memory required for storing these soft decisions is proportional to the retransmission time interval. Fast hybrid ARQ has been proposed to decrease retransmission delay which in turn decreases the memory requirements at the receiver.

In prior art schemes, the whole ARQ protocol is in the radio link control (RLC) layer and the feedback data as well as the retransmissions have been generated in the RLC layer as described in the Release 1999 3GPP specifications. This type of feedback data is not suitable for fast HARQ if the RLC in the network side is located in the radio network controller (RNC) since the Iub interface between RNC and Node B (the base station) can cause long delays. The delay of the Iub interface is one of the main reasons for the long round trip delays. This prior art technique requires that the retransmission delay becomes very high (typically from approximately ten to twenty

transmissions in time intervals (TTIs). This retransmission delay therefore implies that the memory requirements at the transmitter, but especially in the receiver, must be very high in order to be able to retransmit and soft combine the retransmitted packets with the stored packets which were received erroneously.

One way to speed up the whole process is to generate the feedback data in the physical layer of the receiver. Similarly, the retransmissions should be generated at the physical layer of the transmitter. Alternatively, the feedback and the retransmission can also be generated in a layer which is co-located with the physical layer, thereby eliminating any long delay between these two layers.

There are several ways of transmitting the feedback data. One possibility is to transmit it through existing uplink or downlink channel. This has the problem that the existing channels are usually terminated in the radio network controller (RNC) in the network side, i.e., thee is the delay between the base station and the RNC. Even if the termination of the existing transport channel were changed to a base station in the network side, the transmission delay would be at least three TTIs more than that of the proposed invention since the existing transport channels are interleaved at least over ten milliseconds (ms) (see 3GPP spec).

All the previous implies that a separate fast feedback channel needs to be defined. One straightforward possibility in a CDMA system is to transmit the feedback data using a separate code channel and transmit it in parallel with other data which has been proposed for instance by Motorola Corporation for its one XTREME system. This requires multi-code transmission which is not desirable in the mobile terminal (if the feedback is in the uplink direction).

Summary of the Invention:

The present invention provides a solution for fast feedback associated with fast HARQ and thereby solves the buffering problem associated with other feedback mechanisms. In particular, the technique of the present invention does not require the use of a separate code channel for feedback information

but rather is able to steal some of the capacity from uplink traffic data or control traffic (or downlink traffic depending upon the direction of the packets) in order to provide the necessary feedback data. In another embodiment of the invention, dedicated physical control channel (DPCCH) bits are used for the fast feedback. The method according to the present invention is described with respect to the downlink transmission of a frequency division duplex (FDD) as an example. Thus the feedback is in the uplink direction. Of course, extension of this description to uplink data is straight-forward, wherein the feedback would be in the downlink direction.

Hybrid ARQ is a link adaption technique which is used to improve the performance of wireless communication systems and the Type 1 Hybrid ARQ with soft combining uses a type of repetition coding in which the retransmitted packet is combined with the initially transmitted packet. Type 2 Hybrid ARQ uses an incremental redundancy scheme and thus both in Type 1 and Type 2 Hybrid ARQ soft combining is utilized in the receiver and soft decisions values of the erroneous packets have to be stored in the receiver which of course, can lead to very high memory requirements at the receiver. It is thus clear that the amount of memory required for storing the soft decisions is proportional to the retransmission time interval.

For wireless communication system, the uplink and downlink radio frames have a probable time displacement between the uplink and downlink channels. For dedicated channels, the uplink and downlink frames are typically separated by 1,024 chips. The purpose of the fast feedback is to reduce the time interval for transmitting the feedback after receiving the packet. However, the receiver must typically de-interleave, de-rateмatch, decode and error check the received packets after reception of the radio frame and all of these operations require time. Thus the fastest way to send acknowledgement is to stuff the feedback data in the next frame in the uplink direction so that the transmitter can retransmit the erroneous packets with a delay of only one transmission timing interval (TTI).

The present invention achieves this goal by reserving a few slots, fully or partly, where the number of slots can be a parameter, in the uplink

Dedicated Physical Data Channel (DPDCH) radio frame for feedback data only. This technique implies that data in the uplink direction can be transmitted only in the remaining slots (also in the remaining parts of the slots if the slots are only partly used for feedback). The feedback data is transmitted in slots N_1 to N_2 - 1 and the data in the uplink direction are therefore transmitted in slots 1 to N_1 - 1 and in slots N_2 to N, where N is the number of slots in a radio frame. In this technique, the value of N_1 is dependent upon the time offset between the uplink and downlink channels. It is also dependent upon the time required for any de-interleaving, de-ratematching, decoding and error checking at the receiver. Furthermore, the number of feedback slots (N_{fb}) depends on the size of the feedback packet. If forward ordering is used, the value of N_{fb} is typically three or four slots.

An alternative implementation of the fast feedback channel can use some of the dedicated physical control channel (DPCCH) bits in the given slots. Thus feedback bits can be punctured into the pilot, transmit power control (TPC) bits, transport format combination indicator (TFCI) bits and feedback information (FBI) bits of one or several time slots. Alternatively, the feedback information can be time multiplexed with the existing pilot, TPC, TFCI and FBI bits by, for example, changing the spreading factor of the DPCCH so that more channel bits will be available.

Brief Description of the Drawings:

For a fuller understanding of the nature and object of the present invention, reference should be made to the following detailed description, taken in conjunction with the following drawings in which:

Figure 1 is an illustration of a plurality of downlink and uplink radio frames associated with a wireless communication system, wherein each frame comprises a plurality of slots.

Figure 2 is an illustration of a radio frame with associated slots numbered one through fifteen and showing the usage of

some of those slots for the presentation of feedback data according to the present invention.

Figure 3 is a flow chart showing how rate matching and interleaving are combined with feedback data by a slot multiplexer.

Figure 4 is an illustration of an uplink radio slot and how the dedicated physical control channel (DPCCH) bits can be used to provide feedback data.

Best Mode for Carrying Out the Invention:

As best seen in Figure 1, wireless communication systems typically communicate from a sender to a receiver via uplink and downlink frames **10** and **12**, wherein each frame comprises a plurality of slots **14**. For a typical frame, the number slots is fifteen. Typically there is a time displacement between the uplink and downlink channels. For dedicated channels, the uplink and downlink frames are separated typically by 1,024 chips.

As presented herein, the methodology is described with reference to downlink transmission of frequency division duplex (FDD) wireless communications in which the feedback for such communications is presented in the uplink direction. It will be noted to anyone of ordinary skill in the art that extension to uplink data in which the feedback is presented in the downlink direction is a straight-forward extension of this description and forms part of the present invention.

In the development of wireless communications, the concept of automatic repeat requests has been adopted to allow for the receiver of packets to request that any packet be retransmitted if it was not properly received. Of course, this implies that the sender of such a packet must store that information for possible retransmission until such time that the sender receives acknowledgement from the receiver that the packet has been received properly. The longer the time delay between sending the original packet and receiving the acknowledgement, the longer the sender must store that packet for possible retransmission in the event that it is not properly received by the receiver.

Faced with this problem and the associated expense and complexity of large storage, techniques have been adopted which have modified the original automatic repeat request concept in what is now known as hybrid ARQ (sometimes referred to as HARQ). Hybrid ARQ is a link adaptation technique which is used to improve the performance of wireless communication systems. In what is known as Type 1 hybrid ARQ, there is soft combining where a type of repetition coding is performed in which the retransmitted packet is combined with the initially transmitted packet.

In what is known as Type 2 hybrid ARQ, an incremental redundancy scheme is used. For both Type 1 hybrid ARQ with soft combining, as well as Type 2 hybrid ARQ, the soft decision values of the erroneous packet have to be stored in the receiver which can lead to very high memory requirements at the receiver. It is therefore clear that the amount of memory required for storing the soft decisions is proportional to the retransmission time interval. Fast physical layer hybrid ARQ has been proposed to decrease the retransmission delay which in turn decreases the memory requirements at the receiver.

The present invention describes a fast feedback scheme for a fast physical layer hybrid ARQ for data transmitted in the downlink direction. The invention equally applies to where the data is transmitted uplink direction (feedback in the downlink direction). The purpose of fast feedback is to reduce the time interval for transmitting the feedback after receiving the packet. Upon receiving a packet, a receiver typically performs de-interleaving, de-ratematching, decoding and error detection of the packets in the radio frame and these operations require a finite amount of time to perform. Thus the fastest way to send acknowledgement to the sender of the frame is to send the feedback data in the next frame in the uplink direction as shown by slot **14** within each of the uplink frames. With this method, the transmitter can retransmit any erroneous packets with the delay of only one transmission timing interval (TTI).

As best seen in Figure 2, a practical way to achieve this result is to reserve a few slots (where the number of slots can be a parameter) in the

uplink Dedicated Physical Data CHannel (DPDCH) radio frame for use as feedback data alone. The number of feedback slots (N_{fb}) typically can range in size from two to four slots and resides specifically in slots N_1 to N_2 - 1. Thus N_{fb} is equal to N_2 - N_1. Other data transmitted in the uplink direction is therefore transmitted in slots 1 to N_1 - 1 and in slots N_2 to 15, where 15 slots form a typical radio frame, (that is, where N = 15).

The value of N_1 depends on the time offset between the uplink channel and the downlink channel, as well as dependent upon the time required to perform de-interleaving, de-ratematching, decoding and error checking (typically cyclical redundancy checking). The value of N_{fb} depends on the size of the feedback packet and if forward ordering is used, the value of N_{fb} is typically three or four slots.

If the uplink and downlink radio frames are time aligned as shown in Figure 1, then a typical value for N_1 is 8 and N_2 can be 9, 10, 11 or 12, depending upon the size of the feedback packet (that is N_{fb} can be 1, 2, 3 or 4 slots respectively).

During initial call setup phase, the user equipment (UE) and the network agree upon a suitable size for N_1 and N_2. The network and ratematching unit **20** (see Figure 3) ensure that the uplink data can be accommodated in 15 - N_{fb} slots. The slot multiplexer **22** multiplex the uplink data as well as the feedback packets **24** into the proper slots.

The space or gap for the feedback channel can be generated in the same way as that used for compressed mode, that is by puncturing or by higher layer scheduling. The latter technique is usually more appropriate since the needs for the feedback channel are known beforehand and can be taken into account when defining transport format combinations.

The feedback slot(s) N_{fb} need not necessarily be transmitted during the next radio frame. The feedback can be delayed due to processing delays so as to be presented in a later frame with an associated known offset between the data channel and the feedback channel. However, the feedback channel would itself be implemented in the same manner as described above.

The feedback slots may use the same or a different spreading factor (SF) as the other data. The reason for a different SF can be, for instance, the desire to use a fixed SF for the feedback channel regardless of the SF used for other data. A fixed SF for the fast feedback channel can simplify the reception of the fast feedback channel if a separate receiver is used for the fast feedback channel. A fixed SF for the fast feedback channel can be implemented by repeating the fast feedback bits n times if the SF of the feedback channel is n times larger than the SF of the data channel. If, on the other hand, the same receiver is used for both data and feedback, then the same SF is desirable for both feedback and other data.

Alternative Embodiment

As best seen in Figure 4, an alternative implementation of the fast feedback channel can make use of bits in the dedicated physical control channel (DPCCH) **26** in the given slots of the radio frame. An uplink radio frame is shown in Figure 4. Region **28** is the portion of the DPCCH channel where signalling bits are punctured for use as feedback. Feedback bits can be punctured into the pilot, feedback (FBI) or transmit power control (TPC) fields of one or several time slots. Figure 4 shows feedback bits punctured into the pilot field of uplink DPCCH. Downlink DPCCH can be punctured in a similar fashion. If more than only a few feedback bits are needed, the spreading factor (SF) of the DPCCH can be reduced, thus creating more bits per time slot. The signalling information can then be mapped to some of the uplink slots and there would still be room for pilot, transport format combination indicator (TFCI), FBI and TPC bits. Feedback information can also be encoded within the TFCI field if the number of transport format combinations needed during the connection leaves part or whole of the TFCI field unused. The dedicated physical data channel DPDCH **30** is also shown in Figure 4.

In addition, the present invention can be use for a time division duplex as well as frequency division duplex communication format. For time division duplex, the data is normally transmitted in given slots thereby forming bursts. The use of fast feedback requires that the proper slot (with a given offset to the

other data channel) be allocated for that user. The feedback channel can use a part of the capacity of the burst or the entire burst. Once the required slot is allocated, ratematching can be used to introduce the gap needed for the fast feedback channel and the feedback bits can be added after second interleaving. That is, they can be added before the second interleaving if time slot related second interleaving is used.

In general, the methodology of the present invention can be used for any feedback signalling, especially if the timing requires the use of a certain position within the frame for such signalling. For instance, fast cell site selection can use similar feedback signalling methodology.

Thus what has been described is a method of sending feedback information in a fast automatic repeat request in which received packets are acknowledged by transmitting feedback data to the sender of the packets, wherein the acknowledgement comprises the reservation of a plurality of slots in the uplink dedicated channel radio frame for the feedback data alone. It is also directed to a method of providing fast feedback in which dedicated physical control panel (DPCCH) bits are used in at least some of the slots for transmitting the feedback data to the sender.

What is claimed is:

1. A method of sending feedback information in a fast automatic repeat request for frequency division duplex or time division duplex communication that form an overall wireless communication system having uplink traffic and downlink traffic transmitted in a plurality of slots forming a frame, comprising the steps of:

receiving packets at a receiver, where the received packets are then de-interleaved, de-ratematched, decoded and monitored for error detection; and

acknowledging the received packets by transmitting feedback data to the sender of the packets, said acknowledgement comprising the reservation of a plurality of slots in the uplink or downlink dedicated physical channel radio frame for the feedback data.

2. A method according to claim 1, where there are N slots per frame and wherein the feedback data is transmitted in slots N_1 to N_2-1 and the data in the uplink or downlink direction are transmitted in slots 1 to N_1-1 and in slots N_2 to N, where $N_1 > 1$ and N2 $> N_1 + 1$.

3. A method according to claim 2, wherein the value of N_1 is based upon the time offset between uplink and downlink channels as well as based upon the time required for de-interleaving, de-ratematching, decoding and cyclical redundancy checking.

4. A method according to claim 3, wherein the number of slots reserved for feedback data, ($N_{fb} = N_2 - N_1$) is a function of the size of the feedback packet.

5. A method according to claim 1, wherein the value of N_1 is based upon the time offset between uplink and downlink channels as well as based upon the time required for de-interleaving, de-ratematching, decoding and cyclical redundancy checking.

6. A method according to claim 5, wherein the number of slots reserved for feedback data, ($N_{fb} = N_2 - N_1$) is a function of the size of the feedback packet.

7. A method according to claim 1, wherein the plurality of slots in the uplink or downlink dedicated physical channel radio frame for the feedback data is used for the feedback data only.

8. A method of sending feedback information in a fast automatic repeat request for frequency division duplex or time division duplex communication that form an overall wireless communication system having uplink traffic and downlink traffic, transmitted in a plurality of slots forming a frame, comprising the steps of:

receiving packets at a receiver, where the received packets are then de-interleaved, de-ratematched, decoded and monitored for error detection; and

using less than all of the dedicated physical control channel (DPCCH) bits in at least some of the slots for transmitting the feedback data to the sender.

9. A method according to claim 8, wherein if more than a few feedback bits are required, than the spreading factor (SF) of the DPCCH is reduced, thereby creating more bits per time slot for use at least in part as feedback bits.

10. A method according to claim 8, wherein the feedback data to be transmitted to the sender is punctured into bits of the pilot, feedback (FBI) or transmit power control (TPC) fields in at least one time slot.

11. A method according to claim 8, wherein the feedback data to be transmitted to the sender is punctured into bits of the transport format combination indicator (TFCI) field if the number of transport format combinations needed during the connection leaves part or whole of the TFCI field unused.

12. A method of sending feedback information in a fast automatic repeat request for frequency division duplex or time division duplex communication that form an overall wireless communication system having uplink traffic and downlink traffic transmitted in a plurality of slots forming a frame, comprising the steps of:

receiving packets at a receiver, where the received packets are then de-interleaved, de-ratematched, decoded and monitored for error detection; and

acknowledging the received packets by transmitting feedback data in a feedback channel to the sender of the packets, wherein the feedback channel is generated in the same manner as a channel is generated for compressed mode.

13. A method according to claim 12, wherein the feedback channel is generated by puncturing into fields.

14. A method according to claim 13, wherein the fields are control fields.

15. A method according to claim 14, wherein the fields are control fields and/or data fields.

16. A method according to claim 13, wherein the feedback data can be delayed and therefore presented in a later frame.

17. A method according to claim 12, wherein the feedback channel can be generated by higher layer scheduling.

Abstract of the Disclosure:

A method of sending feedback information in a fast physical layer hybrid automatic repeat request (HARQ) for frequency division duplex communications that form an overall wireless communication system is described in which the received packets are acknowledged by transmitting feedback data to the sender, wherein the acknowledgement comprises the reservation of obtaining a plurality of slots in the uplink/downlink dedicated channel radio frame for the feedback data alone. It is also directed to the transmission of feedback data used in specified slots within each radio frame, wherein the first slot used is based upon the time offset between uplink and downlink channels, as well as based upon the time required for de-interleaving, de-ratematching, decoding and error checking. In an alternative embodiment, the method uses dedicated physical control channel (DPCCH) bits in at least some of the slots for transmitting such feedback data to the sender.

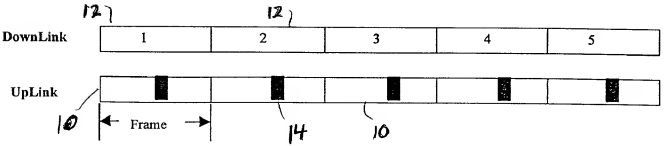


Figure 1 Uplink and DownLink frames

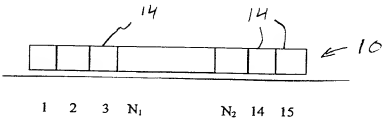


Figure 2 A Radio Frame

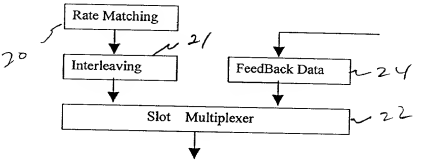


Figure 3

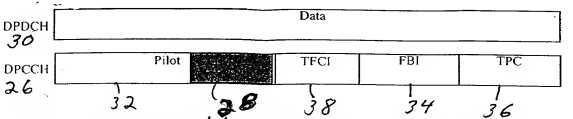


Figure 4 An uplink radio slot. The shadowed part represents the punctured signaling bits in a slot.